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PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Customer No.:	23641	}	
Application No.:	10/607,227	}	
Confirmation No.:	5896	}	I hereby certify that this correspondence is being electronically filed with the Commissioner for Patents
Filing Date:	June 26, 2003	}	on: <u>September 29, 2009</u>
Attorney Docket No.:	50460/83518	}	<u>/Gregory S. Cooper/</u> Gregory S. Cooper
First Named Inventor:	William E. Spindler	}	
Group Art Unit:	1746	}	
Examiner Name:	Bibi Sharidan Carrillo	}	
Title:	Cleaning Compound for Surfaces in a Food Processing Environment	}	

AFFIDAVIT PURSUANT TO 37 C.F.R. § 1.132

Sir:

I, Gregory S. Cooper, do hereby declare and state that:

1. I am new Counsel for the Applicant William E. Spindler.
2. Attached are several documents discussing the corrosive nature of bleach.
 - a. "Performance of Steel Against Corrosion and Peracids Acid Bleach Media" (5 pages):

demonstrating this bleach being corrosive; and

- b. "Infectious Materials Spill, Management, and Cleanup" (2 pages)
states:

paragraph 10 identifies that "bleach will corrode metal, so
all metal surfaces will have to be wiped clean."

- c. "Selection of stainless steels for the food processing industries" (1
page)

- d. "Stainless Steel Fabrication" Allegheny Ludlum Steel Corp.,
Pittsburgh, PA, copyright 1959 (2 pages)

Table I-4 Corrosion Resistance of Allegheny Stainless Steels
Resistance of Basic Types to Corrosion by Various
Media

- e. "Compass Corrosion guide II," Compass Publications, copyright
1983 (4 pages)

- f. "Soda Bleach Solutions," Diamond Shamrock, 1979 (1 page)

Caustic Tanks

- g. "Product Information Manual-Chlorine," Occidental Chemical
Corporation, 1983 (1 page)

Section IV Equipment For Handling Chlorine

- h. "Wet Chlorine"(1 page)

- i. "Chlorination Tanks or Reactors"(1 page)

3. The undersigned declares further that all statements made herein of his own
knowledge are true and that all statements made on information and belief are believed to be
true; and further that these statements were made with the knowledge that willful false
statements and the like so made are punishable by fine or imprisonment, or both, under Section
1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize
the validity of the application or any patent issuing thereon.

Declared at Fort Wayne, Indiana, this 29th day of September, 2009.

Date: September 29, 2009


Gregory S. Cooper

State of Indiana)
) ss:
County of Allen)

On this 29th day of September, 2009, before me, a Notary Public in and for the County and State aforesaid, appeared Gregory S. Cooper, to me personally known to be the same person whose name is subscribed to the foregoing instrument, and acknowledged that he executed said instrument as his free and voluntary act and for the uses and purposes therein expressed.


Notary Public

Zellma M. Katt
Printed Name

My Commission Expires: November 24, 2016

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ENVIRONMENTAL CONTROL

COMPARATIVE ANNUAL COST EFFICIENCY BETWEEN THERMAL AND CHEMICAL OXIDATION OF TRS IN KRAFT MILLS

APPLICATION: Engineers can apply these guidelines to estimate and analyze the annual operating costs for destroying TRS by chemical oxidation as opposed to traditional incineration.

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The customary way to destroy total reduced sulfur (TRS) is to incinerate the high-volume, low-concentration noncondensable gases (HVLC NCG) in a lime kiln, power boiler, recover boiler, or dedicated incinerator. An alternative approach is to oxidize contaminants chemically. Sodium hypochlorite and chlorine dioxide are the main oxidizers used and are readily at hand at any plant that has a bleaching process. A number of these chemical scrubbers have been developed and implemented in mills.

What about the costs? Estimates of annual operating costs are presented for the main options in the thermal and chemical approaches. These estimates are used to evaluate the most cost-efficient option for a plant with a bleaching process. As a rule, thermal incineration is the more cost efficient approach when the HVLC flow is lower than 10,000 N³/m.sup.3/h and TRS loads are higher than 6.8 kg/h. Chemical oxidation is the better alternative when the situation is reversed. In general, the greater the gas flow and the more NCG is diluted, the more attractive chemical oxidation becomes.

What are other mills doing? For low-volume, high-concentration gases, the lime kiln is commonly the primary incineration point, with the power boiler as backup. For HVLC, the most commonly preferred option is the power boiler. A dedicated thermal oxidizer is appropriate for HVLC when a waste fuel source is available and is the cheapest alternative in terms of capital cost if the mill cannot use power or recovery boilers. Chemical oxidation is becoming more popular, especially in Canada. View this paper online at <http://www.tappi.org/index.asp?pid=32716&ch=1>

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COATING

PRINT QUALITY AND THE DISTRIBUTION OF OFFSET INK CONSTITUENTS IN PAPER COATINGS

APPLICATION: Mills, converters, and printers can use the results from this study in optimizing the coating formulations for desired print quality, and in understanding how different coating chemistry changes the printing result.

Article Details

☒ Printer friendly ☒ Cite/link ☒ Email ☒ Feedback

Title Annotation: TAPPI JOURNAL SUMMARIES

Publication: Solutions - for People, Processes and Paper

Date: Jul 1, 2005

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Previous Article: Putting the pressure on compressed air costs.(BACK TO BASICS)

Next Article: Calendar.(Calendar)

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[Visualization of toner ink adsorption at bubble surfaces.\(FLOTATION DEINKING\)](#)

Little is known about the distribution of offset ink components in coated paper, although this is likely to be critical to print quality. This work focused on two fundamental processes that cause differences in distribution of ink constituents into a coating structure during printing. In the first, adsorptive chromatographic fractionation, chemical components of an ink mixture separate on contact with the paper coating due to their different adsorption characters. These differences arise from coating pigment chemistry, surface area, and morphology variables. In the second, latex-oil diffusion, molecular movement due to a concentration gradient takes place as oil molecules penetrate into the polymer latex matrix.

Our results indicated that adsorptive chromatographic fractionation, and the resulting distribution of ink constituents in a coating structure after printing, affected print quality parameters such as print gloss and density. Latex-oil diffusion and its constituents' distribution affected ink setting dynamics during printing, but did not influence print gloss or density. The inference is that adsorption onto the paper coating material surfaces delays permeation (sorption into the coating paper) of the slightly polar ink oils, hence delaying the concentration of solved ink resins on the ink-coating interface. Absorption through diffusion of ink oils by the paper coating latex internal matrix usually takes longer. In volumetric terms, it occurs away from the initial critical concentrating region of ink setting and cohesive ink tack build-up. Superimposed on these effects is the capillarity arising from the packing of pigments and binders. View this paper online at <http://www.tappi.org/index.asp?pid=32717&ch=1>

Sanna Rousu is technical customer services manager, Stora Enso UK, Orpington, UK; Patrick Gane is head of research and development, Onya Development AG, Oftringen, Switzerland; Dan Eklund is emeritus professor, Abo Akademi University, Finland. Email Rousu at sanna.rousu@storaenso.com

BLEACHING

EFFECT OF COOKING CONDITIONS ON ECF BLEACHING AND BRIGHTNESS REVERSION OF BIRCH KRAFT PULPS

APPLICATION: The concentrations of hydroxide ion and hydrogen sulfide ion in a birch kraft cook have an impact on the results of ECF bleaching.

To what extent do the kappa number of the pulp and the concentrations of hydroxide ion and hydrosulfide ion in the cooking liquor influence

ECF bleaching during birch kraft pulping?

To study this question, we carried out cooks with high and low levels of hydroxide ions and hydrosulfide ions. The pulps were cooked to two different kappa number levels and were bleached in both OD(EOP)DnD and OD(EOP)DP bleaching sequences. The parameters studied were kappa number, brightness, HexA content, and brightness reversion in both humid and dry atmospheres.

A higher hydroxide ion level during kraft cooking gave a brighter unbleached pulp and a somewhat higher final brightness in both the OD(EOP)DnD and OD(EOP)DP sequences. A higher level of hydrosulfide ion during kraft cooking did not give a higher unbleached brightness, but it led to better brightness development during the ECF bleaching sequences.

The kappa number reduction during bleaching was not influenced by the cooking variables studied, and the final kappa number was not critical for the final bleached brightness. A cooking kappa number increase from 16 to 22 gave a 17% increase in chlorine dioxide consumption in the OD(EOP)DnD sequence.

The humid brightness reversion correlated with the HexA content after bleaching, but the dry brightness reversion did not correlate with any of the studied parameters. For the humid atmosphere, a final D stage gave less brightness reversion than a final P stage, but the reverse was true for the dry atmosphere. View this paper online at <http://www.tappi.org/index.asp?pid=32718&ch=1>

At the time of this work Magnus Bjorklund was at Karlstad University. Currently he and Jiri Basta are with Eka Chemicals AB, SE-44580 Bohus, Sweden. Ulf Germgard is at Karlstad University, SE-65188, Karlstad, Sweden. Email Bjorklund at magnus.bjorklund@eka.com

ADDITIVES AND FILLERS

CALCIUM CARBONATE COMPOSITE FILLERS

APPLICATION: Increasing the percentage of calcium carbonate in paper could reduce production costs and improve the performance of paper.

Composites of precipitated calcium carbonate (PCC) and pulp were produced by co-precipitating calcium carbonate on top of nonwood and wood pulps. These composites were added to a base pulp, from which handsheets were produced. The handsheets were compared with two types of reference handsheets, one made by adding commercial PCC to the base pulp and one made by adding a blend of PCC and pulp to the base pulp.

The results showed that increasing the amounts of composite filler in handsheets decreases the bulk of paper. Tensile strength was similar for composite and PCC reference handsheets. The Scott bond strength for samples with composite filler added was higher than for the PCC reference samples. Internal bond strength was highest for bagasse composite sheets. Light scattering and opacity were higher for the composite papers than for the reference handsheets. Lower strength and higher optical properties were obtained for handsheets with composite fillers added than for handsheets prepared from the blend reference.

Scanning electron microscopy pictures of the samples showed that the PCC is spaced along the length of the fibrils in the composite filler. Hence, the highly refined pulp fibers and PCC form a porous network. The adhesion of PCC to the fiber surfaces prevents the cellulose fibrils from completely collapsing and bonding. Thus, in composite sheets, a higher fraction of the cellulose surface area is available for light scattering, which increases the optical performance. View this paper online at <http://www.tappi.org/index.asp?pid=32719&ch=1>

Ramjee Subramanian is a research associate, Laboratory of Paper Technology, HUT, Finland, Thad Maloney is with KCL, Espoo, Finland. Hannu Paulapuro is a professor, Laboratory of Paper Technology, HUT, Finland. Email Subramanian at rsubrama@cc.hut.fi.

CORROSION

PERFORMANCE OF STEELS AGAINST CORROSION IN PERACID BLEACH MEDIA

Long-term immersion and electrochemical corrosion tests help in identifying appropriate material of construction for handling peracid bleach media of lower pH.

Peracids are among the nonchlorine bleach chemicals that have been studied for use in papermaking. Considering the fact that change of chemicals affects the corrosivity of the bleach media, we investigated the corrosivity of peracid solutions and the corrosion performance of various steels in them.

We subjected austenitic stainless steels (304L, 316L, 317L) and a duplex stainless steel (2205) to electrochemical polarization and weight loss tests at room temperature and at 50[degrees]C. The tests show peracetic acid ([P.sub.a]) to be most corrosive, followed by a mixture of peracetic acid and Caro's acid ([P.sub.xa]), and Caro's acid ([P.sub.x]). Comparison of the corrosivity of peracid solutions with those of other prevailing bleach chemicals show it to be less corrosive than peroxide and chlorine dioxide up to 1000 ppm chlorine. The test materials can be put in following order of increasing corrosion resistance: 304L < 316L < 317L < 2205. A suggestion on appropriate material for handling these liquors has been listed below:

Solutions	[P.sub.x] 1	[P.sub.x] 2	[P.sub.xa] 1	[P.sub.xa] 2
Room Temp.	304L	2205	304L	304L
50 [degrees]C	304L	2205	304L	2205
Solutions	[P.sub.a] 1	[P.sub.a] 2	[P.sub.a] 0	
Room Temp.	2205	2205	304L	
50 [degrees]C	2205	2205	304L	

([P.sub.a]=peracetic acid, [P.sub.x]=Caro's acid, [P.sub.xa]=mixture of [P.sub.x] and [P.sub.a])

Thus, peracetic and Caro's bleaching solutions at pH 5 could be handled in the acid stages of existing bleach plants with equipment built for previous CEDED-type bleaching sequences or today's chlorine dioxide/peroxide sequences. View this paper online at <http://www.tappi.org/index.asp?pid=32720&ch=1>

Gayaan Singh and Ajay Kumar Singh are with the Department of Paper Technology, Indian Institute of Technology, Roorkee, Saharanpur Campus, P.B. 83, Saharanpur-247001, India.

ONLINE EXCLUSIVE ENVIRONMENTAL

USE OF KRAFT RECOVERY CYCLE RESIDUALS IN MINERALIZATION OF FORESTS-- CONTROLLING LEACHING RATES OF LIMITED SOLUBLE SPECIES

APPLICATION: Many inorganic solid residuals from the kraft pulp industry can be recycled back to the forest. This paper describes methods for modifying and evaluating the leaching behavior of lime mud and green liquor dregs. The information will be useful to companies reusing these materials in the forest.

We sought to find a method to recycle inorganic solid residuals from the kraft recovery cycle as vitalizing agents, especially in acidified forests. One such method is pelletization, followed by thermal treatment, which sinters the material into a more stable and dense matrix with a low dissolution rate due to the small available surface area. Predicting the leaching rate from pelletized residuals in natural environments requires an understanding of both the hydrodynamic mass transport properties of the acidic solution-pellet system and the heterogeneous reaction kinetics on the pellet surface. This study examines the leaching rates of limited soluble species, such as calcium, from single pellets of treated lime mud and green liquor dregs under well-controlled laboratory leaching tests. Results indicate a significant effect of the physical structure of the pellets on leaching properties of calcium. We developed models that describe the leaching rates. We found that a combined mass transfer and surface reaction describes the leaching rate of limited soluble species at a pH level of 5.5. The mass transfer of hydrogen ions to the surface is determined as the rate-determining step at a pH level of 4.6. We concluded that by using a combination of well-controlled experiments and mathematical modeling, it is possible to understand the different phenomena that control the leaching mechanism of limited soluble species. View this paper online at <http://www.tappi.org/index.asp?pid=32721&ch=1>

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APPENDIX 4

INFECTIOUS MATERIALS SPILL, MANAGEMENT AND CLEAN UP

Initial spill clean-up of blood or OPIM must be performed by appropriate lab personnel as specified by the laboratory director. The spill clean up must be followed by the use of an approved disinfectant (chemical germicide) that is tuberculocidal (e.g. EXPOSE) or a solution of 5.25% sodium hypochlorite (household bleach) diluted 1:10 with water.

1. In most cases, the person who caused the infectious spill is responsible for cleaning it up. If a spill is of unusual danger (large volume of liquid or aerosols are present), evacuate the area and call the Health and Safety Division (HSD) at X5890 or the emergency operator at X5555.
2. Always wear two pairs of disposable gloves, when cleaning up spills (i.e. nitrile or latex gloves are recommended). Immediately replace them if they become too grossly contaminated. If any waste comes in contact with skin, immediately remove gloves and wash hands with plenty of soap and water.
3. Wear a laboratory coat and eye protection to avoid exposure to the infectious materials. Do not clean up a spill if infectious aerosols are present. Leave the laboratory, close the door, post a sign, notify the supervisor and contact HSD X5890.
4. Never pick up broken glass with bare or gloved hands. Use forceps or needle-nosed pliers to pick up broken glass. Place broken glass into a plastic needle discard bucket before attempting to wipe up the spill.
5. Spills of hazardous viable biological agents should be saturated with a suitable disinfectant (household bleach) and allowed 20 minutes contact time before the spill is cleaned up.
6. For small spills of infectious liquids (100 cc or less), place absorbent towels over the spill. Carefully absorb liquid onto the towel without getting the waste over your gloves. Do not widen the spill area by carelessly wiping the liquid across the floor. Once covered with towels, carefully mist contained spill with 1:10 bleach solution to begin the disinfection process.
7. For spills of greater than 100 cc, an appropriate absorbent may be placed onto the liquid. Scrape up the wet absorbent with a plastic scoop and place the waste into a red bag.
8. Thoroughly clean-up the spill area with moist paper towels and place the waste into a red bag. Avoid the creation of aerosols which could cause an exposure. The initial mechanical cleaning of the spill area must be very thorough (no visible blood), otherwise the chemical disinfection will not be effective.
9. Use an approved disinfectant or germicide to disinfect the spill area. For example, a fresh 1:10 (one part bleach to ten parts water) solution may be used or a diluted solution of EXPOSE with 1-3% phenolics is acceptable.
10. Wipe the entire spill area with the disinfectant solution. If the mechanical cleaning was thorough and the contaminated area is sufficiently wiped with a suitable disinfectant, the infectious agents will be inactivated.
11. Wipe forceps or pliers with the disinfectant solution and rinse with water. Bleach will corrode metal, so

all metal surfaces will have to be wiped clean. If the spray bottle was touched with contaminated gloves, the bottle itself should be wiped with the disinfectant solution.

12. Dispose of all contaminated towels, papers, absorbent, and gloves into a red bag. If the lab coat is contaminated, place it into a plastic bag and autoclave before laundering.
13. Wash hands thoroughly with soap and water after the job is done.



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Selection of stainless steels for the food processing industries

Introduction

Stainless steels are widely used in food and beverage manufacturing and processing industries for manufacture, bulk storage and transportation, preparation and presentation applications.

Depending on the grade of stainless steel selected, they are suitable for most classes of food and beverage products. Guidelines on the Materials of Construction for Equipment in Contact with Food have been published by the European Hygiene Engineering and Design Group (EHEDG). This includes an extensive section on stainless steels. Copies of these Guidelines can be ordered from this website.

Stainless steels used in food processing

Most containers, pipework and food contact equipment in stainless steels is manufactured from either 304 or 316 type austenitic stainless steels.

The 17% chromium ferritic stainless steel (430 type) is also used widely for such applications as splashbacks, housings and equipment enclosures, where corrosion resistance requirements are not so demanding.

In addition to these non-hardenable austenitic and ferritic types higher strength 'duplex' types, such as grades 1.4362 and 1.4462 are useful for 'warm' conditions (i.e. over 50°C) where stress corrosion cracking (SCC) can be a corrosion risk, such as in brewery sparge tanks.

Hardenable "martensitic" type stainless steels are widely used for cutting & grinding applications, especially as knives.

Is 316 type the only stainless steel that is classed as the 'food' grade

The '316' grades (1.4401 / 1.4404) are often referred to as the 'food' grades.

There is no known official classification for this and so, depending on the application, the equally common 1.4301 and 1.4016 grades may be suitable for food processing and handling, bearing in mind that in general terms the corrosion resistance ranking of grades can be taken as: -
1.4401/1.4404 (316 types) > 1.4301 (304 types) > 1.4016 (430 types)

Corrosion hazards to stainless steels in food processing

If the grade of stainless steel is correctly specified for the application, corrosion should not be encountered. Surface finish and condition is very important to the successful application of stainless steels. Smooth surfaces not only promote good cleanliness but also reduce the risk of corrosion.

The types of corrosion to which stainless steels can be susceptible are summarised below. This can be useful in identifying problems due to wrong grade selection or inappropriate use of equipment.

Pitting and Crevice Corrosion

Both crevice and pitting corrosion occur most readily in aqueous chloride-containing solutions. Although attack can occur in neutral conditions, acidic conditions and increases in temperature promote pitting and crevice corrosion.

Pitting corrosion is characterised by local deep pits on free surfaces.

Crevice corrosion is occurs in narrow, solution-containing crevices or sharp re-entrant features in a structure. Examples of potential sites for crevice corrosion are under washers, flanges and soil deposits or growths on the stainless steel surface.

Stress Corrosion Cracking

'SCC' is a localised form of corrosion characterised by the appearance of cracks in materials subject to both stress and a corrosive environment. It usually occurs in the presence of chlorides at temperatures generally above 50°C.

Intergranular Corrosion

'IGC' or 'ICC' (known in the past as 'weld decay') is the result of localised attack, generally in a narrow band around heat affected zones of welds. This is more likely to occur in the 'standard' carbon austenitics. The risk of IC attack is virtually eliminated if the low carbon (0.030% maximum, eg 1.4307) or the 'stabilised' (eg 1.4541) types are selected.

Cleaning of stainless steel equipment

Effective cleaning is essential in maintaining the integrity of the process and in prevention of corrosion. The

"Stainless Steel Fabrication" Allegheny Ludlum Steel Corp. Pittsburgh, PA Copyright 1959

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TABLE I-4—CORROSION RESISTANCE OF ALLEGHENY STAINLESS STEELS

TABLE

RESISTANCE OF BASIC TYPES TO CORROSION BY VARIOUS MEDIA

CODE: a—Unaffected. b—Slightly attacked. c—Attacked. m—Complete details concerning the conditions of service should be submitted before selecting the grades for resistance to these media.

Except where otherwise stated, all tests are conducted on cp. materials, saturated solutions of salts, at room temperature.

	AL Stainless			
Medium	302	316	430	410

ORGANIC SUBSTANCES

Acetone	a	a	a	b
Alkaform anesthesia	a	a	c	c
Benzol	a	a	a	a
Camphor	a	a	a	a
Carbon disulfide	a	a	..	..
Carbon tetrachloride	m	m	m	m
Carbon tetrachloride (vapors refluxed)	m	m	m	m
Coffees	a	a	a	a
Copal varnish	a	a	a	a
Ethyl alcohol	a	a	a	a
Ethyl chloride	a	a	a	a
Ethyl ether	a	a	a	a
Food pastes	a	a	a	a
Formaldehyde	m	m	m	m
Fruit juices	a	a	a	a
Furfural	a	a	..	..
Gasoline	a	a	a	a
Glue	m	m	m	m
Ink	m	m	m	m
Iodoform dressing	c	a	..	..
Methyl alcohol	a	a	a	a
Methyl chloride	a	a	..	..
Milk—fresh or sour	a	a	a	a
Mustard	m	m	m	m
Naphtha	a	a	a	a
Oils—mineral and vegetable	a	a	a	a
Paraffin (molten)	a	a	a	a
Paregoric cmpd.	a	a	..	b
Pine tar oil	a	a	..	..
Quinine bisulfate	b	a	..	c
Quinine sulfate	a	a	..	b
Rosin (molten)	a	a	a	a
Soaps	a	a	a	a
Sodium salicylate	a	a	a	a
Soy bean oil	a	a	..	..

	AL Stainless			
Medium	302	316	430	410

ORGANIC SUBSTANCES—Cont.

Tomato juice	m	m	m	m
Trichlorethylene	m	m	m	m
Tung oil	a	a	..	..
Vinegar at 70 F.	m	m	m	m
Vinegar (plus 0.5% salt, 200 F.)	m	m	m	m
ACIDS				
Acetic	m	m	m	m
Acetic vapor	m	m	c	c
Arsenic (150 F)	a	a	..	..
Arsenic (225 F)	b	..	..	..
Arsenious	a	a	a	..
Benzoic	a	a	a	a
Boric	m	a	m	..
Butyric	a	a	a	..
Carbolic	m	m	c	c
Chloracetic	c	c	..	..
Chlorosulfonic (conc.)	m	m	..	c
Chlorosulfonic (10%)	b	..	..	c
Chromic (50%)	c	c	..	..
Chromic	c	c	c	c
Citric	a	a	..	b
Cresylic	a	a	..	..
Chromic (plus 10% potassium ferricyanide)	..	..	..	b
Formic	c	m	..	c
Gallie	a	a	a	..
Hydrobromic	c	c	..	..
Hydrocyanic	a	a	c	c
Hydrochloric	c	c	c	c
Hydrofluoric	c	c	c	c
Lactic	a	a	a	b
Lactic plus salt	m	m	..	..
Malle	a	a	..	b
Molybdic	a	a	..	..
Nitric (conc.)	a	a	a	a
Nitric (conc. plus 2% HCl)	a	..	c	c
Nitrous (conc.)	a	a	a	b

ACH
Oleic
Oxali
Phos
Phos
Picric
Pyrog
Pyrol
Steari
Succi
Sulfu
Sulfu
Sulfu
pot
Sulfu
Tanni
Tarta
Trich
Uric
SALT
Alum
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0.5'
Bariu
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Bleac
Borde
Calcit
Calcit

14 TABLE I-4—CORROSION RESISTANCE OF ALLEGHENY STAINLESS STEELS (CONT'D.)

Medium	AL Stainless			
	302	316	430	410

SALTS—Cont.

Potassium hydrate.....	a	a	a	a
Potassium nitrate.....	a	a	a	a
Potassium oxalate.....	a	a	a	a
Potassium permanganate...	a	a	a	..
Potassium sulfate.....	a	a	a	a
Silver bromide.....	a	a	a	a
Silver nitrate.....	a	a	a	a
Silver cyanide.....	a	a	a	..
Sodium acetate.....	a	a	..	..
Sodium bicarbonate.....	a	a	a	..
Sodium bichromate.....	a	a	a	..
Sodium bisulfate.....	a	a	..	..
Sodium borate.....	a	a	a	..
Sodium bromide.....	a	a	..	b
Sodium carbonate (10%)...	a	a	a	a
Sodium carbonate (50%)...	a	a	a	..
Sodium chlorate (10%)....	a	a	a	..
Sodium chlorate (25%)....	a	a	a	..
Sodium chloride.....	m	m	..	..
Sodium chloride (2% aerated).....	a	a	b	..
Sodium citrate.....	a	a	a	a
Sodium fluoride.....	b	..	..	..
Sodium hydroxide.....	a	a	a	a
Sodium hypochlorite (Dakin's solution).....	m	m	c	c
Sodium hypochlorite (sat. — slightly alkaline) (200 F).....	a	a	..	b
Sodium lactate.....	a	a	..	..
Sodium nitrate.....	a	a	a	a
Sodium nitrite.....	a	a	..	..
Sodium peroxide (212 F)...	a	a	..	..
Sodium phosphate.....	a	a	..	..
Sodium sulfate.....	a	a	a	a
Sodium sulfide.....	a	a	a	a
Sodium sulfite.....	a	a	a	a
Sodium thiosulfate (plus 4% potassium meta bisulfate).....	a	a	a	a
Sodium thiosulfate 20% plus acetic acid 20%....	m	m	m	c
Soda ash (10%) (200 F)....	a	a	a	a
Soda ash (50%) (200 F)....	a	a	a	a
Stannic chloride.....	c	c	..	c
Stannous chloride.....	b	..	c	c

Medium	AL Stainless			
	302	316	430	410

SALTS—Cont.

Sulfur (molten) 500 F.....	a	a	a	..
Sulfur chloride.....	b	..	..	..
Sulfur oxychloride.....	a	a	..	..
Titanium tetrachloride.....	a	..	..	..
Zinc chloride.....	c	b	..	c
Zinc sulfate.....	a	a	a	a
MISCELLANEOUS				
Aluminum (molten).....	c	c	c	..
Ammonia.....	a	a	a	..
Baking oven gases.....	a	a	a	a
Beer.....	a	a	a	a
Bromine.....	c	c	c	c
Bromine water.....	c	c	c	c
Cadmium (molten).....	c	c	..	..
Carbonated beverages.....	a	a	a	a
Chlorine (wet and dry)....	c	c	c	c
Cider.....	a	a	a	a
Copper sulfate electroplating solution.....	a	a	..	..
Copper cyanide electroplating solution.....	a	a	..	..
Glycerin.....	a	a	a	a
Gold cyanide electroplating solution.....	a	a	..	..
Hydrogen sulfide (400 F)...	m	m	..	..
Iodine.....	c	m	c	c
Lead (molten).....	c	c	..	..
Linseed oil.....	a	a	..	b
Lysol.....	m	m	c	c
Meats.....	a	a	..	..
Mercury.....	a	a	..	..
Mine water.....	m	m	m	m
Nickel sulfate electroplating solution.....	a	a	..	..
Sauerkraut brine.....	m	m	..	..
Sea water.....	m	m	..	c
Silver cyanide electroplating solution.....	a	a	..	..
Steam and air (refluxed)...	a	a	..	b
Steam, CO ₂ , and air.....	a	a	..	b
Steam, SO ₂ , CO ₂ , and air...	m	m	b	b
Sulfur dioxide.....	m	m	..	..
Syrup.....	a	a	..	..
Vegetable juices.....	a	a	a	a
Water.....	a	a	a	a
X-ray developing solution..	m	m
Zinc (molten).....	c	c	c	c

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	ALUMINUM 3003	CARBON STEEL 1018	STAINLESS STEEL 430F	STAINLESS STEEL 303 & 304	STAINLESS STEEL 316	STAINLESS STEEL CARPENTER 20Cb-3
SODIUM BROMIDE	NR 90% at 70°F C 10% at 70°F A dilute to 70°F	NR dilute at 70°F	NR 30% at 70°F C dilute at 70°F pits on drying	NR 20-50% at 160°F B dilute to 70°F pits on drying	B 10-50% at 125°F A dilute to 70°F pits on drying	B 100% to 212°F B 10-40% to 212°F A dilute to 70°F
SODIUM CARBONATE (SODA ASH)	NR 10-100% at 70°F	AB to 120°F	B 100% to 70°F AB 10-30% to 212°F A 5% to 150°F	B 100% to 600°F AB 10-30% to 212°F A 5% to 150°F NR molten	A 10-100% to 212°F B 100% to 500°F NR molten	A 10-100% to 125°F A 100% to 300°F B 100% 300-400°F A 10-30% to 212°F
SODIUM CHLORATE	C/NR 100% at 70°F B 10-60% to 212°F		B 100% to 70°F B 10-50% to 70°F	B 100% to 70°F B to 70% to 212°F	B 10-100% to 140°F B 10-60% to 212°F	B 10-100% to 70°F B 10-60% to 212°F
SODIUM CHLORIDE	B 100% to 70°F C 100% boiling C 10-30% at 70°F	B/NR to 70°F	C 100% to boiling pits on drying B 20% to 212°F B 5% to 150°F	AB to 100% to 70°F C 100% boiling pits on drying B 20-30% to 212°F	A 100% to 212°F NR 90% at 70°F B 20-30% to 212°F NR 10% at 125°F	A 100% to 70°F B 10-40% to 212°F
SODIUM CHROMATE	B 10-100% to 212°F	AB to 70°F	B 10-100% to 212°F	B to 100% to 212°F	B 100% to 70°F A 10-50% to 212°F	B 10-100% to 212°F
SODIUM CITRATE	NR 10-100% at 70°F		A 100% to 70°F B to 40% to 70°F	A 100% to hot B to 40% to 212°F	B 10-100% to 100°F B 10% to 212°F	B 10-100% to 70°F B 10-40% to 212°F
SODIUM CYANIDE	NR 10-100% at 70°F	B to 70°F	A 100% to 70°F pits on drying A 10-20% to 212°F	B 100% to 70°F pits on drying A 10-30% to 212°F C fused at 1291°F	A 10-100% to 140°F NR 30% at 212°F A 10% to 212°F C fused at 1292°F	A to 100% to 212°F
SODIUM DICHROMATE	AC 100% to 70°F B 10% to 70°F	AC to 70°F	B to 100% to 212°F	B to 100% to 212°F	B to 100% to 212°F	B to 100% to 212°F
SODIUM FERRICYANIDE	A to 70°F		B 10% to 70°F pits	B 10 & 100% to 70°F A 5% hot, pits	B 10-100% to 70°F A 5% to hot	B 10-100% to 70°F
SODIUM FLUORIDE	B 5% to 70°F	NR 5% at 70°F	C 10% at 70°F pits NR 10% at 212°F	BC 10% to 70°F NR 10% at 212°F pits on drying C/NR 8% at 140°F	C/NR 8% at 140°F A 5% to 70°F pits on drying	C 8% at 175°F
SODIUM HYDROXIDE (CAUSTIC SODA)	NR 10-100% at 70°F NR 100% at 500°F NR 50% at 300°F	C 30-100% to 180°F NR 73% at 100°F AB 20-70% to 100°F NR 30-50% at 190°F	NR 50-90% boiling B 10-80% boiling A 10-30% to 125°F	B 50-80% to 70°F NR 70% 190-210°F AB 10-50% to 125°F	NR 50-100% at 400°F stress cracks B 30-50% to 212°F A 10-20% to 212°F	B 100% at 300°F B 30-50% to 300°F A 10-20% to 210°F
SODIUM HYDROXIDE MOLTEN >604°F	NR	NR	NR	B/NR	B/NR	AB
SODIUM HYPOCHLORITE	NR at 70°F	NR at 70°F	NR 10-100% at 70°F BC 5% to 70°F pits	C 20% at 70°F AB 5% to 70°F pits A to 1% to 212°F	BC 20% to 140°F A to 6% to 70°F NR 5% at 70°F still A to 1% to 212°F	C 20% to 140°F A to 1% to 80°F A 6% to 100°F
SODIUM HYPOSULFITE	NR at 70°F	NR at 70°F	C 10-100% at 70°F	AB 100% to 70°F A 25% boiling NR 5% at 70°F still	AB 100% to 70°F A 1% boiling	A 5% to 70°F
SODIUM METAPHOSPHATE	AC to 70°F	NR at 70°F	B to 70°F	A to 70°F	A to 140°F	A to 140°F
SODIUM METASILICATE	B 100% to 70°F NR 10% at 70°F	B to 230°F	A 10-100% to 212°F	A 10-100% to 212°F	A 10-100% to 212°F	A 10-100% to 212°F
SODIUM NITRATE	B 100% to 70°F A 10-90% to 70°F	AB to 130°F	A 100% to 70°F NR 100% at 160°F B to 30% to 70°F	B 100% to 70°F A to 70% to 212°F	B 100% to 140°F A 10-90% to 212°F B 10-90% at 230°F	B 100% to 140°F A 10-90% to 212°F
SODIUM NITRATE MOLTEN >588°F	NR		AC	AC	A	
SODIUM NITRATE	AC to 70°F	A to 70°F		AC to 70°F	AC conc. to 200°F AB to 20% to 70°F	
SODIUM PERBORATE	AC 100% to 70°F NR 10% at 70°F	AC to 100°F	AB 100% to 70°F B 10% to 250°F	A 100% to 70°F B 10% to 250°F	A 100% to 70°F C 100% at 140°F B 10% to 212°F	A 100% to 125°F B 100% to 212°F
SODIUM PEROXIDE	A/NR to 70°F	AC to 70°F	AB to 70°F	A to 212°F	A 10 & 100% to 212°F	A to boiling
SODIUM PHOSPHATES	NR 10-100% at 70°F	AC 100% to 150°F AB 10% to 212°F	AB to 100% to 212°F neut. & alk. NR at 70°F acid	AB to 100% to 212°F neut. & alk. B to 70°F acid	AB 10-100% to 212°F	AB 10-100% to 212°F neut. & alk.

A <.002 in. per year (<.05 mm/yr.)
 B <.020 in. per year (<.50 mm/yr.)
 C <.050 in. per year (<1.27 mm/yr.)
 NR >.050 in. per year or explosive; not recommended.

	HASTELLOY B	HASTELLOY C	INCONEL	INCOLOY 825	NICKEL	MONEL
SODIUM BROMIDE	B 10-60% to 212°F	B 10-60% to 212°F A 5% to 100°F	B 5% to 70°F	A 5% to 70°F	B dilute to 70°F	B 10-50% to 175°F A dilute to 70°F
SODIUM CARBONATE (SODA ASH)	A 10-100% to 212°F B 100% to 1500°F	A 10-100% to 212°F B 100% to 1500°F	AB to 100% at 212°F A 5% to 150°F	A to conc. to 70°F A 8% to 175°F	A 22% at 750°F A 10% to 70°F A 5% to 150°F	A 10-100% to 70°F A 100% to 250°F A 10-30% to 212°F A 5% to 150°F
SODIUM CHLORATE	AB to 200°F	AB 10-60% to 212°F	AB 25% to 70°F	A 25% to 70°F A 0.2% to 175°F		NR 100% at 500°F A 10-60% to 212°F
SODIUM CHLORIDE	A to 100% to 212°F	A to 100% to 212°F	A 5-100% to boiling	A to 88% to 175°F A to 5% to 220°F cavities cracks	A 5-100% to boiling	A 100% to boiling C 40-90% at 212°F A 10-40% to 212°F
SODIUM CHROMATE	A 10-100% to 212°F	A 10-100% to 212°F				AB 10-100% to 212°F
SODIUM CITRATE	A 100% to 70°F B 10-50% to 70°F	A 100% to 100°F B 10-50% to 70°F	AB to 70°F	A to 70°F	AB to 70°F	B to 70°F
SODIUM CYANIDE	AB to 200°F	A to 200°F	B to 70°F		B 100% to 70°F A 5% to 70°F	NR to 100% at 70°F NR 100% at 1300°F NR 10% boiling
SODIUM DICHROMATE	B 10% to 70°F	A conc. to 70°F B 10% to 70°F	AB to 70°F	A at 70°F neutral B 2-6% 150-160°F		
SODIUM FERRICYANIDE	A 100% to 125°F B 10% to 70°F	A to 210°F B 10% to 70°F		A to 70°F		
SODIUM FLUORIDE	B 10% to 70°F A 5% to 70°F	A to 200°F A 5% to 100°F	AB 5% to 70°F		A 5% to 70°F	A 5% to 70°F
SODIUM HYDROXIDE (CAUSTIC SODA)	A 100% to 200°F NR 70-100% at 300°F stress cracks A 10-70% to 212°F	A 100% to 200°F B 10-70% to 212°F	B 60% boiling A 50% to 150°F	A to 75% to 265°F	A 100% to 70°F A 10-80% to 570°F B 60-70% boiling	A to 70% to 212°F B to 70% at 250°F
SODIUM HYDROXIDE MOLTEN >604°F	NR	NR	B		A	B (stress cracks)
SODIUM HYPOCHLORITE	AB to 100°F A 5% to 70°F	AB 100% to 100°F A 20% to 100°F A 10% to 70°F	NR 5-100% at 70°F C 5% at 70°F	A 6.3% to 100°F may pit A 5% to 212°F	NR 5-100% at 70°F C 5% at 70°F	NR 5-100% at 70°F C 5% at 70°F
SODIUM HYPOSULFITE	B to boiling	B to boiling	AB 5 to 100% to 70°F	A to 70°F	A to 70°F	A to 70°F
SODIUM METAPHOSPHATE				A 15% to 175°F		A to 70°F
SODIUM METASILICATE	A 10-100% to 212°F	A 10-100% to 212°F	A to 230°F		A to 230°F	A 10-100% to 212°F
SODIUM NITRATE	AB to 200°F	B 30-100% to 150°F A to 30% to 70°F	A to 100%	A to conc. to 70°F A to 6% to 212°F	A to 70°F	B 100% to 70°F B 10-70% to 212°F
SODIUM NITRATE MOLTEN >598°F			A to 70°F		A to 70°F	B to 70°F
SODIUM NITRATE			B to 70°F	A to conc. to 70°F A to 6% to 212°F	B to 70°F	B 100% to 70°F A to 90% to 212°F
SODIUM PERBORATE	B 100% to 212°F AB conc. to 70°F B 10% to 212°F	B 10% to 212°F	A to 70°F		B to 70°F	B 100% to 70°F B 10% to 212°F
SODIUM PEROXIDE	NR 100% at 212°F B 10% to 212°F	B 100% to 100°F B 10% to 212°F	A to 70°F AB to 212°F	A to 212°F	B to 212°F	B to 212°F
SODIUM PHOSPHATES	AB 10-100% to 212°F	A 10-100% to 212°F	A to 70°F	A to 55% to 185°F	A to 70°F	A 10-100% to 212°F

A <.002 in. per year (<.05 mm/yr.)
 B <.020 in. per year (<.50 mm/yr.)
 C <.050 in. per year (<1.27 mm/yr.)
 NR >.050 in. per year or explosive; not recommended.

	COPPER NICKEL 70-30	COPPER NICKEL 90-10	ADMIRALTY BRASS	NAVAL BRONZE & YELLOW BRASS	SILICON BRONZE	COPPER
SODIUM BROMIDE	A 5% to 70°F	A 5% to 70°F		B 10% to 70°F	A 5% to 70°F	A 5% to 70°F
SODIUM CARBONATE (SODA ASH)	A to 70°F	A to 70°F		B 100% to 70°F C 10% at 70°F NR 15% hot	A to 70°F	A to conc. to 70°F
SODIUM CHLORATE	AB 25% to 70°F	AB 25% to 70°F		B 100% to 70°F C 30% at 70°F	AB 25% to 70°F	AB 25% to 70°F
SODIUM CHLORIDE	AB to sat'd. to boiling	AB to sat'd. to boiling		C conc. at 70°F NR 100% boiling B 10-30% to 212°F AB 10% to 70°F	B to sat'd. to boiling	B conc. to 70°F BC 3-100% boiling B 3% to 70°F
SODIUM CHROMATE				B 10-100% to 212°F		
SODIUM CITRATE	A to 70°F	A to 70°F			A to 70°F	A to 70°F
SODIUM CYANIDE				NR 10-100% at 70°F	NR at 70°F	NR at 70°F
SODIUM DICHROMATE	A to 70°F	A to 70°F		AC conc. to 70°F NR 10% at 70°F	A to 70°F	A/NR to 70°F
SODIUM FERRICYANIDE	A to 70°F	A to 70°F		NR 10% at 70°F	A to 70°F	A to 70°F
SODIUM FLUORIDE	A 5% to 70°F	A 5% to 70°F		B 5% to 70°F	A 5% to 70°F	B/NR 5% to 70°F
SODIUM HYDROXIDE (CAUSTIC SODA)	A 30-50% to 180°F B 30-50% at 190°F A 50% to 180°F NR 50% at 300°F	A 50% to 70°F NR 50% at 300°F	NR 50% at 300°F BC 4% at 70°F	B 100% to 212°F NR 70-100% at 300°F NR 50% 70-212°F B 10-30% to 212°F	C 100% at 70°F NR 50% at 300°F B 10% at 70°F	NR 100% at 70°F NR 50% at 300°F BC 4% at 36°F still
SODIUM HYDROXIDE MOLTEN >504°F	NR	NR	NR	NR	NR	NR
SODIUM HYPOCHLORITE	NR at 70°F	NR at 70°F	NR at 70°F	NR 20-100% at 70°F	C at 70°F	BC conc. at 70°F C/NR 5% at 70°F
SODIUM HYPOSULFITE	B 5% to 70°F	B 5% to 70°F		NR at 70°F	B 5% to 70°F	B 5% to 70°F
SODIUM METAPHOSPHATE				C at 70°F	B to 70°F	B to 70°F
SODIUM METASILICATE				B 10-100% to 212°F		
SODIUM NITRATE	AB to 100% to 70°F	AB to 100% to 70°F		C 100% at 70°F B 10-40% to 70°F	B to 100% to 70°F	AC to 70°F
SODIUM NITRATE MOLTEN >566°F						
SODIUM NITRATE	A to 70°F	A to 70°F		AC to 70°F	A to 70°F	B to 70°F
SODIUM PERBORATE				A/NR to 70°F	B to 70°F	B to 70°F
SODIUM PEROXIDE	B to boiling	B to boiling		C/NR at 70°F	B to boiling	BC to boiling
SODIUM PHOSPHATES	A to 70°F	A to 70°F		B 10-100% to 212°F	A to 70°F neutral B to 70°F acid B to 70°F alkaline	A to 70°F neutral B to 70°F acid B to 70°F alkaline

A <.002 in. per year (<.05 mm/yr.)
 B <.020 in. per year (<.50 mm/yr.)
 C <.050 in. per year (<1.27 mm/yr.)
 NR >.050 in. per year or explosive; not recommended.

	NI RESIST (TYPE)	COLUMBIUM	TANTALUM	TITANIUM	ZIRCONIUM	CARBON-GRAPHITE RESIN IMPREGNATED
SODIUM BROMIDE	B boiling (1,2)		A to 300°F	A to 70°F	A to 70°F	A to 340°F
SODIUM CARBONATE (SODA ASH)	A 5-10% to 70°F (1,2)	NR 100% 70-212°F AB 20% boiling	AC to 300°F	A 100% to 200°F A 20% boiling		A to 340°F
SODIUM CHLORATE			A to 300°F	A to 220°F	A to 70°F	A/NR 100% to 70°F A 25% to 130°F
SODIUM CHLORIDE	A conc. at 180°F B conc. at 200°F A 5% to 86°F (1,2,D2) v = 6 ft./min.	A to 212°F	A to 300°F	A sat'd. to 200°F A 25% to boiling crevice corrodes	A sat'd. to boiling A to 30% to 212°F	A to 340°F
SODIUM CHROMATE						A to 340°F
SODIUM CITRATE			A to 70°F	A to 70°F		A to 100°F
SODIUM CYANIDE	A 136-154°F (1,2,)			A to 200°F		A to 340°F
SODIUM DICHROMATE			A to 70°F	A to 70°F		A to 340°F
SODIUM FERRICYANIDE			A to 70°F			A to 340°F
SODIUM FLUORIDE			NR 5% at 70°F	A to 70°F	A 20% to 70°F	A to 340°F
SODIUM HYDROXIDE (CAUSTIC SODA)	B 75% at 275°F (2,3) A 50% to 70°F (2,3) B 50% at 170°F (2,3) A 30% to 180°F (4)	NR conc. at 70°F B 5% to 70°F NR 5% at 212°F	NR 100% at 70°F NR 50% at 300°F A 5% boiling	NR 100% at 70°F NR 50% at 300°F A to 60% to 140°F	A to 100% to 70°F B 70% at 212°F B 50% at 300°F A to 30% to 212°F	A to 30% to 275°F
SODIUM HYDROXIDE MOLTEN >604°F	C (3)	NR	NR	NR	NR	NR
SODIUM HYPOCHLORITE		NR at 70°F	A to 300°F	AC 100% to 200°F A 20% to 180°F	A 100% to 70°F A 10% to 212°F	A/NR 100% to 70°F AB to 25% to 150°F
SODIUM HYPOSULFITE			A 5% to 70°F			A to 100°F
SODIUM METAPHOSPHATE						A 100% to 70°F A 25% to 150°F
SODIUM METASILICATE	A at 230°F (1,2)					
SODIUM NITRATE		A to 70°F	A to 300°F	A to 200°F	A to 70°F	AC to 340°F
SODIUM NITRATE MOLTEN >560°F						NR
SODIUM NITRATE			A to 70°F	A to 70°F	A to 60% to 212°F	A 100% to 100°F A 25% to 150°F
SODIUM PERBORATE						AC 100% to 70°F A 25% to 150°F
SODIUM PEROXIDE			NR boiling			A 100% to 70°F A 25% to 130°F
SODIUM PHOSPHATES	A 5% to 70°F (1,2)		A to 70°F	A to 70°F	A to 100% to 212°F	A to 340°F

A <.002 in. per year (<.05 mm/yr.)
 B <.020 in. per year (<.50 mm/yr.)
 C <.050 in. per year (<1.27 mm/yr.)
 NR >.050 in. per year or explosive; not recommended.

Equipment

CAUSTIC TANKS

Since metals are detrimental to the stability of bleach, caustic for bleachmaking should be handled in the best practical way to minimize metals being dissolved into the caustic solution.

Where 50% caustic is diluted directly into a chlorination tank or a continuous bleach system, the 50% caustic storage should be lined to prevent iron from being picked up and conveyed into the bleach.

Where 50% caustic soda is diluted to 25% or less with unsoftened water and then settled or filtered before being transferred to chlorination vessel, the caustic storage or dilution tanks can be plain steel. Iron dissolved by high concentrations or hot solutions of caustic will precipitate with the calcium and magnesium (hard water salts) when 50% caustic is diluted with unsoftened water, cooled, and settled or filtered.

Avoid any use of copper, zinc, or aluminum in a caustic soda system. All are readily dissolved in caustic and extremely active catalysts that accelerate the decomposition of bleach.

Nickel is quickly attacked by bleach and greatly accelerates the decomposition of bleach. However, because nickel is almost totally resistant to caustic under 300° F., nickel is most successfully used for steam coils in 50% caustic storage tanks. If iron or stainless steel should be used for steam coils in caustic storage, be sure to use only low-pressure steam (under 12 psi).

Caustic soda tanks should have two outlets. The outlet for transfer of solution to process should be 4 or more inches off the bottom to guard against entrainment of sediment. Another outlet should be in the lowest point of the bottom of a caustic tank to allow easy cleaning. Dilution tanks will accumulate a sediment caused by the precipitation of hard water salts and other metals.

A caustic soda dilution tank should be emptied and the sediment rinsed out the drain annually or more frequently if necessary to prevent sediment from accumulating close to the process solution outlet. Metals and other impurities are concentrated in the sediment, and a small amount of sediment unintentionally transferred to the chlorination vessel can be enough contamination to cause poor quality sodium hypochlorite.

Steel tanks in caustic service become passivated and a gray-black film forms on the metal. Thereafter, caustic under 130° F. will dissolve very little iron from the tank. The protective film should be preserved whenever practical. Therefore, when sediment is rinsed from a tank, only the bottom should be washed. Then a caustic solution should be put into the tank as soon as the washing is finished. Otherwise a soft rust will quickly form that will contaminate any future storage.

SECTION IV EQUIPMENT FOR HANDLING CHLORINE

PIPING SYSTEMS FOR DRY CHLORINE

The general requirements tabulated here have been abstracted from "Piping Systems for Dry Chlorine Pamphlet 6", issued by the Chlorine Institute Inc., 842 Madison Ave., New York City, New York 10017, which should be referred to for specific details.

SERVICE	DRY CHLORINE LIQUID OR GAS	DRY CHLORINE GAS
Limitations	to 300 PSIG at -20°F to +300°F	to 150 PSIG at -20°F to +300°F
Pipe 3/4" thru 1-1/2"	Sch 80 carbon steel ASTM A106 Gr. A or B	
Pipe 2" thru 6"	Sch 80 carbon steel ASTM A53 Gr. A or B Type S	Sch 40 C. S. ASTM A53 Gr. A or B Type E or S
Screwed or Socket Weld Construction Thru 1-1/2" Pipe Size		
Fittings scr'd or socket weld	3000# Forged Carbon Steel ASTM A105	
Unions Screwed or Socket	3000# Forged Carbon Steel ASTM A105 Steel Seats	
Flanged Unions	1500# Forged Carbon Steel T&G 2-4 Bolt ASTM A105	
*Valves Globe	800# Forged Steel Screwed OS&Y Hast. C Stem Monel Seat	
Ball **	300# Cast Steel Screwed Monel or Hast. C ball & stem PTFE Seal and Seat	
Plug **	300# Ductile Iron screwed Monel plug PTFE sleeve & seal	
Thread Dope	PTFE Tape or Paste	
Welded or Flanged Construction thru 6" Pipe Size		
Fittings Butt Welding	Sch 80 Carbon Steel ASTM A234 Gr. WPB	Schedule matching pipe
Flanges Pipe-Slip-on	Class 300 1/16" Raised Face Forged Carbon Steel ASTM A105	Class 150
Fittings Weld Neck	Class 300 1/16" Raised Face Forged Carbon Steel ASTM A105	Class 150
Gaskets Ring Type	1/16" thk. 3/4" to 1-1/2" 1/8" 2" to 6"	High Temp. Compressed Asbestos Fed. Spec. HHP 46E
Tongue & Groove Type	1/8" Chemical Lead 2-4% antimony or asbestos as above	

SERVICE	DRY CHLORINE LIQUID OR GAS	DRY CHLORINE GAS
Limitations	to 300 PSIG at -20°F to +300°F	to 150 PSIG at -20°F to +300°F
Gasket Dope	None Permitted	
Bolts & Nuts	(See Pamphlet 6) Heavy Hex Head Carbon Steel ASTM A307 Gr. B	
*Valves Globe	Class 300	Class 150 Flanged Cast Steel Hast. C stem Monel seat & plug
Ball **	Class 300	Class 150 Flanged Cast Steel Hast. C or Monel ball & stem PTFE seal
Plug **	Class 300	Class 150 Flanged Cast Steel Monel plug & stem PTFE sleeve & seal

* All valves to be cleaned by manufacturer for chlorine service

** Ball or plug valves for liquid chlorine service must have relief passages from the ball or plug cavity to the high pressure side. (See pamphlet 6)



WET CHLORINE

Wet chlorine is very corrosive to all of the common construction metals. Generally, it can be handled at low pressures in chemical stoneware, glass, porcelain, rubber-lined steel and certain plastics. Gold, platinum and silver are resistant. Titanium is resistant only to wet chlorine and tantalum is inert to both wet and dry chlorine up to 300°F. Applications of this type are very special and the chlorine equipment manufacturer or Technical Service should be contacted for recommendations.

CAUTION

Organic materials mixed with chlorine quite often create potentially explosive conditions. Equipment, instrumentation, and piping vendors may not be fully aware of the hazards which can be created, and competent technical advice should be obtained. Unfortunately, many of the organic materials which can react explosively with chlorine are widely used in chlorine service by unsuspecting users.

These materials would include, but not necessarily be limited to:

1. Polypropylene (used as filter elements).
2. Silicone oil (used as stable fluid in instrument diaphragms such as differential pressure cells, integral orifice flow meters, and chemical seal pressure gauges).
3. Dibutylphthalate (commonly used in pressure transmitters).
4. Therminol(s) heat transfer fluid.
5. Hydrocarbon oils (commonly used in diaphragm and other type pumps for chlorine service).
6. Glycerin (commonly used in instruments).
7. Drawing wax, used to slip loose lines inside steel tanks and pipe.

CHLORINATION TANKS OR REACTORS

Satisfactory Materials of Construction

1. Fiberglass-reinforced resin tanks with rich-resin interior. The resin should have suitable resistance to caustic soda, chlorine, and bleach production.
2. Equipment made of or lined with:
 - (a) Titanium.
 - (b) Kynar (fluorinated polyvinylidene).
 - (c) Teflon (fluorinated polyethylene).
 - (d) Ethylene Propylene Rubber.
 - (e) Chlorobutylene Rubber or equal.
 - (f) Polypropylene.
 - (g) PVC.

Chlorination Tank Design

It is important to have suitable outlet at the lowest point of the tank bottom for washing of settled impurities from the tank.

Bleach production is usually discharged from an outlet a few inches off the tank bottom.

Covered tanks are advisable to help protect bleach from contamination and to contain any vapors for suitable disposition. Along with desired inlets, the top should have a manway with a transparent cover.

The bottom of the chlorination tank should have brackets or stanchions for fixing the chlorine sparger pipe a few inches off the tank bottom and restricting the sparger's vibration.

Even though bleach storage is less severe service than bleach production, bleach storage tanks should be made of materials used for chlorination tanks. Bleach should be protected from direct sunlight and heat.

Continuous Reactors for Manufacturing Bleach

Streams of caustic soda and chlorine can be fed continuously into a mixing reactor to form bleach.

The chlorination is automatically controlled by instrumentation sensing the oxidation reduction potential of the bleach solution.